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REPORT
CD NO.

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COUNTRY	USSR	DATE OF INFORMATION	1950 - 1951
SUBJECT	Economic - Coal		
HOW PUBLISHED	Bimonthly periodical	DATE DIST.	25 Jun 1952
WHERE PUBLISHED	Moscow	NO. OF PAGES	4
DATE PUBLISHED	Jan - Feb 1952		
LANGUAGE	Russian	SUPPLEMENT TO REPORT NO.	

THIS IS UNEVALUATED INFORMATION

SOURCE Planovoye Khozyaystvo, No 1, 1952.

USSR EXPERIMENTS WITH NEW TYPES OF COAL FOR COKING

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The USSR has experimented considerably in the use of new types of coal for coking. Before the Revolution, the only types used for this purpose were K (coking) and PZh (steam-fat) coals, with the occasional use of PS (steam-caking) coal. G (gas) coal was not used at all. By 1940, some coke by-products plants in the South used 7.5 percent G coal in their coke-oven charges. By 1950, this figure had been raised to 14.8 percent. At present, some plants use as much as 25 percent.

A further increase in the supplies of coal suitable for coking is a problem which must be solved by Soviet coke chemists. The Donbass in particular contains large reserves of G coal, and maximum utilization of this coal is one of the most important tasks facing the entire chemistry of coke in the South.

The Donbass also contains large amounts of T (lean) and D (long-flame) coals which are not used for coking purposes at present. About one half of all explored G coal and nearly three quarters of all T coal are high-grade as to sulfur content, while only one third of K, PZh, and PS coals, the types most widely used in coking, are high-grade as to sulfur content. The sulfur content of the coal is a very important factor in production of blast-furnace coke with a low sulfur content.

At present, all coke by-products plants in the South having Dinas brick coke batteries prepare blast-furnace coke from an almost uniform charge with the following contents:

1. In plants with coal-cleaning plants: G coal, 18-20 percent; PZh coal, 40-44 percent; K coal, 18-25 percent; and PS coal 16-22 percent.

2. In plants without coal-cleaning plants: G coal, 12-15 percent; PZh coal, 44-52 percent; K coal, 20-24 percent; and PS coal, 15-22 percent.

At present, supplies of coal suitable for coking are increased by the inclusion of new coals without a radical change in the composition of the coke-oven charge. Each plant has its own planned charge, to which new coals may be added

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if necessary, but only in conformity with the basic type structure of the charge. Any change occurring in the content of the charge is slight. Such a system limits the possibilities of the plants. Consideration should also be given to a radical change in the composition of the charge and the establishment of a different procedure to conform with different characteristics of blast furnaces in individual metallurgical plants.

It has long been assumed that K coal is the basic component of a charge for the production of blast-furnace coke. K coal yields coke of good structure, only slightly cracked, and not apt to crush in transport from the coke ovens to the blast furnace. The reputation of K coal is confirmed by metallurgists who require as much K coal as possible to step up blast-furnace operations.

If the range of coals for coking is to be extended, the composition of coke-oven charges in plants in the South must be radically changed. Suitable experiments must be carried on under plant conditions; during these experiments, specific factors interfering with the production of high-grade coke must be pointed out and eliminated.

The Donbass is, at present, engaged in greatly changing the composition of its coke-oven charges. Workers in Stalino are obtaining coke and pig iron without using K coal. Workers in Yenakiyevo are successfully experimenting with the use of D coal. There is an urgent need to conduct plant experiments with reduced amounts of K and PS coal in the charge, and to introduce G and other types of coal. The Stalino Coke By-products Plant conducted very interesting experiments in 1949, concluding with conversion to a new charge not containing K coal. Prior to the complete conversion of the plant, box cokings were carried on; after conversion, 4-day industrial cokings in ovens were conducted. Starting on 1 July 1949 and continuing through the present, the Stalino Plant has operated without using K coal. The contents of the new charge are as follows: G coal, 25 percent; PZh coal, 45 percent; and PS coal, 30 percent. During the experimentation period, the quality of the coke was as follows: drum specimen, 318-341 kilograms; ash content, 9.3-10.4 percent; and sulfur content, 1.61-1.82 percent These figures are monthly averages; the fluctuation was considerably more in a daily cross section.

The Stalino Plant's new charge also could be used by other coke by-products plants which supply coke for blast furnaces of approximately the same size -- for example, the Dnepropetrovsk Plant. The charge now being used at the Dnepropetrovsk Plant contains 20 percent PS coal; if the plant were converted to the new charge, this figure would be raised to 30 percent. However, since there is also a shortage of PS coal, the problem under consideration can be solved only by finding substitutes for PS coal also. In this connection, D and T coal deserve consideration.

At the Yenakiyevo Plant, box, oven, and battery experiments in coking were conducted and then 10-day experimental blast-furnace melts were made using coke from a charge containing D coal from Kurakhovka Mine No 40 of the Krasnoarmeyskugol' Trust. The sulfur content of this coal is 2 percent as against 3 percent in PS coals. The most favorable charge consisted of the following: D coal, 10 percent; G coal, 18 percent; K coal, 23 percent; and PZh coal, 49 percent. The drum sample of the coke from this charge varied from 313-326 kilograms, the ash and sulfur contents were kept to their former level, and the productivity of the coke ovens and blast furnaces remained unchanged. The coefficient of exploitation of the useful volume of blast furnace No 1 was 0.93 as against a planned 0.95, and of furnace No 4, 0.78 as against a planned 0.82. Consumption of coke per ton of pig iron was 972 kilograms for furnace No 1 as against a planned 1,047 kilograms and 852 kilograms for furnace No 4 as against a planned 930 kilograms.

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In the Yenakiyevo Plant a slight decrease in the gross coke output (1.5 percent) and of the blast-furnace coke output (one percent) occurred. At the same time, the yield of chemical by-products rose sharply -- in particular, benzene (average 7 percent) and coke gas -- as a result of the increased amount of volatile substances in the new charge (D coal contains 42 percent volatile substances but PS coal contains only 17 percent).

One ton of coke is several times cheaper than one ton of tar or other chemical by-products of coking. The output of coke from one ton of charge is usually 75-80 percent; the yield of chemical by-products and coke gas is 20-25 percent. However production costs of the latter, in specific plants, amount to 28 percent of total production costs, while blast furnace coke and tailings account for 72 percent. T and D coals are cheaper than other coals used for coking. D coal is 24 percent cheaper than PS coal and T coal is 11 percent cheaper. PS coal in turn, is 11 percent cheaper than K coal. Any drop in the technical and economic indexes resulting from a change in the composition of the coke-oven charge is usually compensated for by the lower price of the substitute coal used.

At the Stalino Plant, the yield in metallurgical coke was decreased 0.55 percent by the use of the new charge and the gross yield of coke was decreased 0.5 percent. In spite of this drop in output, savings were made as follows: the charge, including G coal, was less expensive; the output of coke was increased; railroad charges were reduced, since local coals were used.

Supplies of D coal in the Kuraknovka Mine No 10 are adequate for the use of both the Yenakiyevo and Gorlovka plants. The PS coal released in these two plants can be sent to the Dnepropetrovsk Plant to be used in a charge without K coal, but with an increased amount of G coal. The K coal released in the Dnepropetrovsk Plant will not only make possible the introduction of D coal in the Yenakiyevo and Gorlovka plants, but will improve the quality of coke for large blast furnaces by increasing the K coal element in the coke-oven charges of several plants.

At present. the Donbass mines a considerable amount of low-sulfur (one-percent) T coal, but questions of the technological preparation and composition of charges containing T coal have been studied inadequately to date.

The production of blast-furnace coke depends on two factors: (1) the coal charge must contain an adequate amount of fusible substances; and (2) the quality of the fusible substances should be such that when decomposition gases are released the most favorable pressure is created in the bulging coal charge. This pressure contributes to the production of tough, large-lump coke.

The toughest coke with the fewest cracks is obtained from K coal. This type of coal develops more pressure during the coking process than other types of coal. In coking a charge consisting only of G coal or PZh coal, a tough coke is not produced, in spite of the fact that these coals contain an adequate amount of fusible substances. These coals yield a spongy, though well fused, coke, because, in the fusing stage, a liquid, easily moving mass is formed which offers no resistance to the passage of the decomposition gases through it. For this reason, no bulging pressure is created and, at the moment of transition from a liquid to a solid state (semicoke), some layers of the substance are not pressed firmly against each other. A charge made up of K and PS coals contains a relatively small amount of fusible substances, but their nature is such that they offer great resistance to the passage of the decomposition gases, thus creating considerable bulging pressure in the charge and bringing about a tight packing of separate layers in the transition from the liquid to the solid state.

The Novo-Makeyevka Coke By-products Plant set up a special crushing department to crush T coal for coke-oven charges. In the fourth quarter of 1950 and the first half of 1951, mass industrial experiments were conducted there using T coal. However, the Donets Coal Institute has proved that T coal, subjected to only normal crushing, may be used in a coke-oven charge. In the experiments conducted by the institute, several variants of the charge with an increased amount of K coal, but without any PS coal, were used. In all cases, 10 percent of the charge consisted of T coal. The experiments yielded coke with high mechanical properties. However, industrial utilization of charges containing T coal and tests of the coke obtained in blast-furnace melts will be necessary to secure complete data on the suitability of T coal for the production of high-grade coke.

For industrial purposes, a charge with the following contents can be recommended: T coal, 10 percent; K coal, 25 percent; PZh coal, 45 percent; G coal, 20 percent; or T coal, 10 percent; K coal, 25 percent; PZh coal, 40 percent; PS coal, 10 percent; and G coal 15 percent. These new charges should be used in coke by-products plants which have their own coal-cleaning plants. The industrial tests of the coke should be made in plants with medium-size blast furnaces and with a sinter plant for sintering ores.

T coal can be used not only in Dinas brick coking ovens, but also in firebrick ovens. In the fourth quarter of 1950, the Smolyaninovskiy Coke By-products Plant conducted lengthy experiments using the following charge: PZh coal, 65 percent; K coal, 25 percent; and T coal, 10 percent. The drum test of the experimental coke conformed to standards of the GOST for foundry coke. The yield of chemical by-products did not vary. In 1951, Glavkoks converted three plants to continuous operation on the new charge on the basis of the experiments of the Smolyaninovskiy plant.

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